

Analysis of Skeletal Muscle Metrics as Predictors of Functional Task Performance

Jeffrey W. Ryder, Roxanne E. Buxton, Elizabeth Redd, Melissa Scott-Pandorf, Kyle J. Hackney, James Fiedler, Robert J. Ploutz-Snyder, Jacob J. Bloomberg
Lori L. Ploutz-Snyder, FACSM.

Universities Space Research Association, Houston, TX, University of Houston, Houston, TX, Wyle Integrated Science and Engineering Group, Houston, TX, Syracuse University, Syracuse, NY, NASA Johnson Space Center, Houston, TX

PURPOSE: The ability to predict task performance using physiological performance metrics is vital to ensure that astronauts can execute their jobs safely and effectively. This investigation used a weighted suit to evaluate task performance at various ratios of strength, power, and endurance to body weight.

METHODS: Twenty subjects completed muscle performance tests and functional tasks representative of those that would be required of astronauts during planetary exploration (see table for specific tests/tasks). Subjects performed functional tasks while wearing a weighted suit with additional loads ranging from 0-120% of initial body weight. Performance metrics were time to completion for all tasks except hatch opening, which consisted of total work. Task performance metrics were plotted against muscle metrics normalized to “body weight” (subject weight + external load; BW) for each trial. Fractional polynomial regression was used to model the relationship between muscle and task performance.

RESULTS: The R^2 values for normalized muscle performance versus task performance are presented in the table below.

	Supine Seat Egress and Walk	Object Pick Up and Carry	Ladder Treadmill	Hatch Opening
IKKE/BW	0.47	0.27	0.41	0.07
KEMIF/BW	0.47	0.37	0.52	0.26
LPMIF/BW	0.68	0.52	0.60	-
LPP/BW	0.49	0.37	0.59	-
LPW	0.51	0.32	0.56	-
BPMIF/BW	-	0.34	-	0.61
BPP/BW	-	0.18	-	0.62
BPW	-	0.21	-	0.73

IKKE, isokinetic knee extension peak torque; KEMIF, knee extension maximal isometric force; LPMIF, leg press maximal isometric force; LPP, leg press power; LPW, leg press work; BPMIF, bench press maximal isometric force; BPP, bench press power; BPW, bench press work.

CONCLUSION: LPMIF/BW is the best predictor of performance for predominantly lower-body tasks that are ambulatory and of short duration.

LPMIF/BW is a very practical predictor of occupational task performance as it is quick and relatively safe to perform. Accordingly, bench press work best predicts hatch-opening work performance.